Alberta

ENVIRONMENT

92-04522/

SUMMARY OF AIR QUALITY MONITORING IN ALBERTA 1990

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This report is one in a series of air quality annual reports produced by Alberta Environment for 1990. The following air quality annual reports are available for 1990:

Summary of Air Quality Monitoring in Alberta: 1990.
Air Quality Monitoring Report for Alberta: 1990 - Technical Report Series No. 92-2a.
Air Quality Monitoring Data Summary for Alberta: 1990 - Technical Report Series No. 92-2b.

For copies of these reports or for more information contact:

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OVERVIEW

The issue of air quality and its effects on the environment has received a great deal of attention over the past decade. Alberta Environment is committed to monitoring air quality and reporting air quality information to the public. A comprehensive air quality network which monitors for 17 major air pollutants is currently operated by Alberta Environment. This network consist of 9 continuous stations, 8 intermittent stations, over 250 static stations and 12 acid precipitation stations. This report is a summary of the information collected by the air quality monitoring program in 1990.

Alberta Environment uses an air quality index to relate Good, Fair, Poor and Very Poor air quality categories with provincial and federal objectives. Outdoor concentrations of carbon monoxide, the coefficient of haze (dust and smoke), nitrogen dioxide, ozone and sulphur dioxide are used to determine this index. Continuous monitoring stations are located in Edmonton (3 stations), Calgary (3 stations), Fort Saskatchewan, Fort McMurray and Fort MacKay. The air quality index was in the Good category at least 89% of the time at all monitoring stations in 1990. The highest frequency of Good air quality ratings was at the Calgary residential monitoring station (northwest Calgary) where air quality was in the Good category 98% of the time. The lowest frequency of Good air quality ratings was at the Fort McMurray monitoring station. Fair air quality was most frequent at Fort McMurray where the index was in this category 11% of the time. Poor air quality occurred occasionally at all monitoring stations. The highest frequency of Poor air quality ratings was at the Calgary industrial (southeast Calgary) monitoring location. On May 25, Very Poor air quality was reported in the industrial area of east Edmonton for three hours due to a dust storm which transported dust from agricultural fields into the city.

The 24-hour regulation for ozone was exceeded on numerous occasions at all monitoring stations. The highest frequency of exceedances was recorded at the Fort Saskatchewan, Calgary residential and Fort McMurray monitoring stations where 143, 162 and 150 days exceeded the regulation, respectively. The frequency of exceedances was less at urban stations which are located close to major traffic arteries. Lower ozone values at urban locations are due to ozone destruction by nitrogen oxide which is emitted by automobiles. Exceedances of the 24-hour regulation were most frequent in the spring and summer at all monitoring stations. High ozone concentrations were likely due to ozone produced through the reaction of sunlight with oxides of nitrogen and hydrocarbons. A portion of high spring time ozone values may be caused by the transport of ozone from the upper atmosphere to ground level. Slight upward trends in annual average ozone values are indicated at the Calgary downtown and Fort McMurray monitoring stations.

Concentrations of carbon monoxide, the coefficient of haze (dust and smoke) and nitrogen dioxide were generally greatest during morning and afternoon rush hours and during the fall and winter seasons. This is due to the combination of vehicular exhaust emissions and stable weather conditions which do not allow pollutants to disperse rapidly. The regulations for carbon monoxide were exceeded at the Edmonton downtown, Edmonton residential and all Calgary monitoring stations. Annual average carbon monoxide concentrations show a downward trend at these monitoring stations. The annual average regulation for nitrogen dioxide was exceeded

at the Calgary downtown monitoring station. A downward trend in nitrogen dioxide concentrations is evident at the Edmonton downtown monitoring station. The guideline for the coefficient of haze was not exceeded at any monitoring stations in 1990. A slight increase in annual average coefficent of haze values in noted at the industrial station located in east Edmonton.

Episodic exceedances of the 1-hour regulation for hydrogen sulphide were observed at the Calgary industrial, Fort McMurray and Fort MacKay monitoring stations. The sources of exceedances at the Calgary industrial station are likely fugitive emissions from industrial facilities in southeast Calgary. The oil sands plants are the most probable sources of exceedances in the Fort McMurray and Fort MacKay regions.

Suspended particulate and dustfall loadings exceeded the regulations or guidelines on numerous occasions at most monitoring stations. The highest frequency of suspended particulate exceedances was at the Calgary industrial monitoring station. Dustfall exceedances were the greatest in the Calgary and Lethbridge areas. The major sources of dustfall and particulates are vehicle exhaust, road dust, agricultural dust and industrial emissions. A downward trend in annual average suspended particulate loadings is evident at the Edmonton residential (northwest Edmonton) and all Calgary monitoring stations. This trend is most significant at the Calgary industrial and downtown stations.

Detailed air quality information and data are available in the reports entitled:

- "Air Quality Monitoring Report for Alberta: 1990"; and
- "Air Quality Monitoring Data Summary for Alberta: 1990".

These reports are available on request from Alberta Environment.

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ABBREVIATIONS

IQUA - index of the quality of the air

O_3 - ozone

CO - carbon monoxide

COH - coefficient of haze

NO_2 - nitrogen dioxide

SO_2 - sulphur dioxide

H_2S - hydrogen sulphide

THC - total hydrocarbons

NH_3 - ammonia

TSP - total suspended particulates

BaP - Benzo (a) Pyrene

Pb - lead

VCM - vinyl chloride monomer

UNITS OF MEASUREMENT

ppm - parts per million by volume

ppb - parts per billion by volume

ug/m^3 - micrograms per cubic meter

ug/1000 m^3 - micrograms per 1000 cubic meters

mg SO_3 equivalent/day/100 sq cm - milligrams as SO_3 per day per 100 square centimeters

mg/100 sq cm/30 days - milligrams per 100 square centimeters per 30 days

ug water soluble fluorides/100 sq cm/ 30 days - micrograms of water soluble fluorides per 100 square centimeters per 30 days

SUMMARY OF AIR QUALITY MONITORING IN ALBERTA: 1990

INTRODUCTION

In the early 1960s, the province began air quality monitoring at one station located in downtown Edmonton. By the mid 1970s, two more stations were added in Edmonton and by the end of the 1970s three stations were established in Calgary. In addition, air quality stations were installed at Fort McMurray, Fort MacKay and Fort Saskatchewan by the early 1980s. Today, a comprehensive network of 9 continuous stations, 8 intermittent stations, over 250 static stations and 12 acid precipitation stations make up the Alberta Environment air quality monitoring program. The objectives of the air quality monitoring program are to:

- *report existing air quality;*
- *determine trends of air quality;*
- *inform the public of adverse air quality conditions; and*
- *conduct monitoring in special problem areas.*

Air quality is an issue that is difficult to assess unless it is put into terms of a single, easily comprehensible indicator. Alberta Environment has adopted an indicator refered to as the Index of the Quality of the Air, or the IQUA.

THE INDEX OF THE QUALITY OF THE AIR (IQUA)

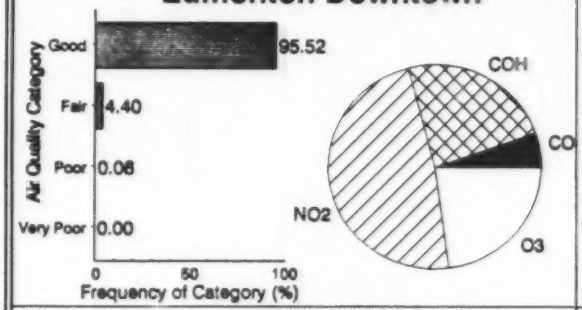
The IQUA relates concentrations of five major pollutants to a common scale which may be easily interpreted by the public. This scale associates Good, Fair, Poor and Very Poor air quality categories with provincial and federal air quality objectives. Outdoor concentrations of carbon monoxide, the coefficient of haze (dust and smoke), nitrogen dioxide, ozone and sulphur dioxide are used to determine the IQUA. The IQUA is reported twice daily (8:15 a.m. and 3:15 p.m.) at Edmonton and Calgary. The index telephone number is 427-7273 in Edmonton and 250-2099 in Calgary.

IQUA rating	Frequency in Alberta	Effects
Good	**almost all the time**	**Desirable range: no known harmful effects to soil, water, vegetation, animals, materials, visibility or human health. The long-term goal for air quality in Canada is to be in this range all the time.**
Fair	**occasional (typical when weather conditions inhibit pollutant dispersion)**	**Acceptable range: adequate protection against harmful effects to soil, water, vegetation, animals, materials, visibility and human health.**
Poor	**very seldom**	**Tolerable range: not all aspects of the environment are adequately protected from possible adverse effects. Long-term control action may be necessary, depending on the frequency, duration and circumstances of the readings.**
Very Poor	**very rare**	**Intolerable range: at this range, further deterioration of air quality and continued high readings could pose a risk to public health.**

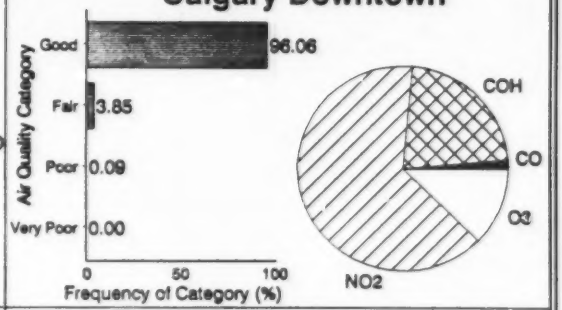
THE INDEX OF THE QUALITY OF THE AIR

Edmonton 427-7273
Calgary 250-2099

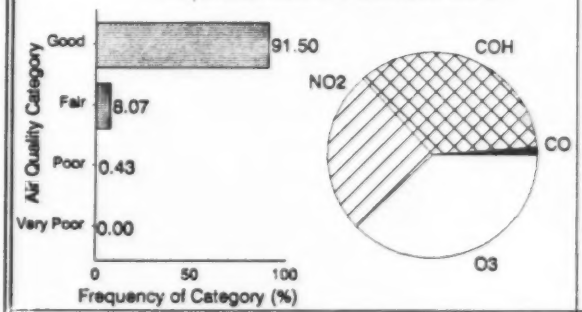
Edmonton Downtown



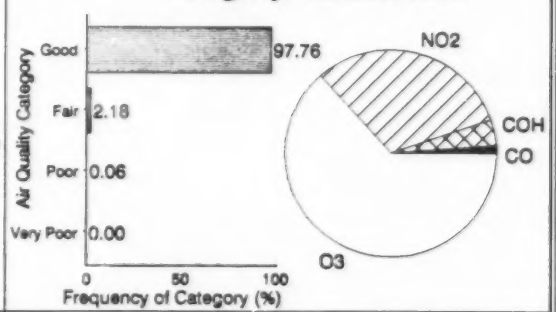
Calgary Downtown



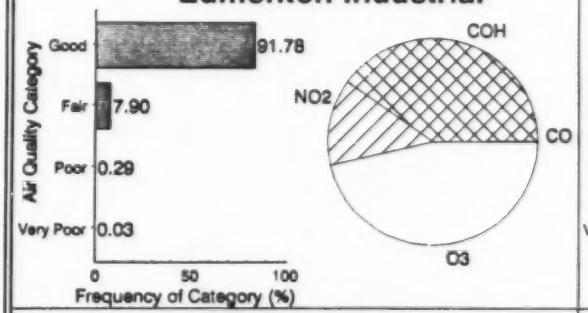
Edmonton Residential



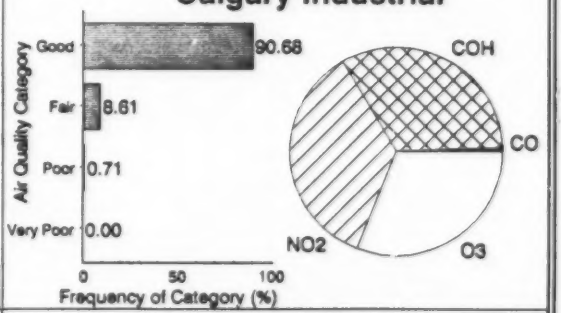
Calgary Residential



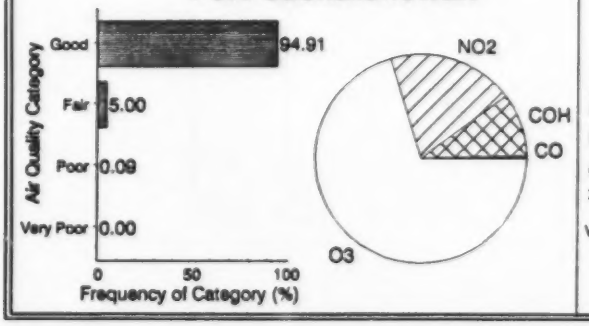
Edmonton Industrial



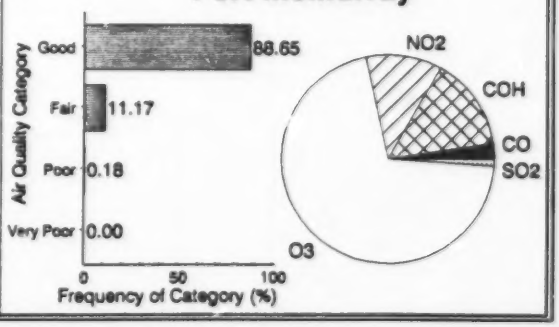
Calgary Industrial



Fort Saskatchewan



Fort McMurray



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The IQUA is calculated each hour at all Edmonton, Calgary, Fort Saskatchewan and Fort McMurray monitoring stations. The air quality index was in the Good category the majority of the time at all Alberta Environment monitoring stations in 1990. The frequency of Good IQUA ratings ranged from 89% at the Fort McMurray monitoring station to 98% at the Calgary residential monitoring station. Fair air quality index ratings were most frequent in the Fort McMurray region (11% of the time). The highest frequency of Poor IQUA ratings was at the Calgary industrial monitoring site (0.7% of the time). The coefficient of haze (dust and smoke) was responsible for most of the Poor IQUA readings at the Edmonton and Calgary monitoring stations. Ozone was the primary pollutant which contributed to Poor air quality ratings at Fort Saskatchewan and Fort McMurray. Very Poor IQUA ratings were observed for three hours on May 25 at the Edmonton industrial monitoring station. Coefficient of haze values were very high on this day due to a dust storm which carried dust from agricultural fields east of Edmonton to the industrial area of the city.

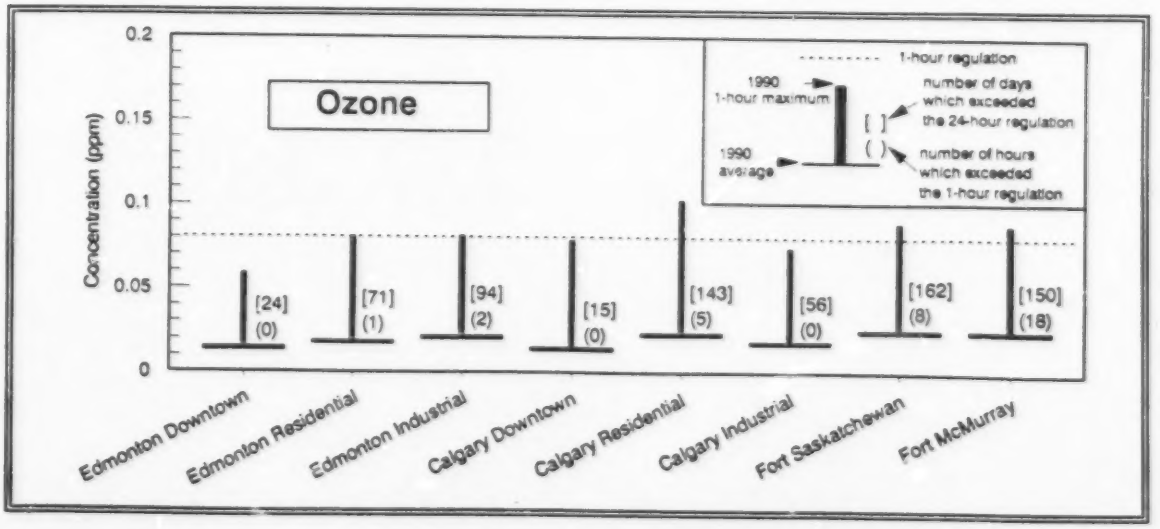
The pollutants responsible for the IQUA ratings are largely dependent on the location of the monitoring station relative to the pollutant sources. For example, in downtown areas of Edmonton and Calgary, pollutants such as carbon monoxide, the coefficient of haze and nitrogen dioxide commonly influence the IQUA rating. In more rural locations, such as Fort McMurray, ozone is often the most common pollutant.

CONTINUOUS AIR QUALITY MONITORING

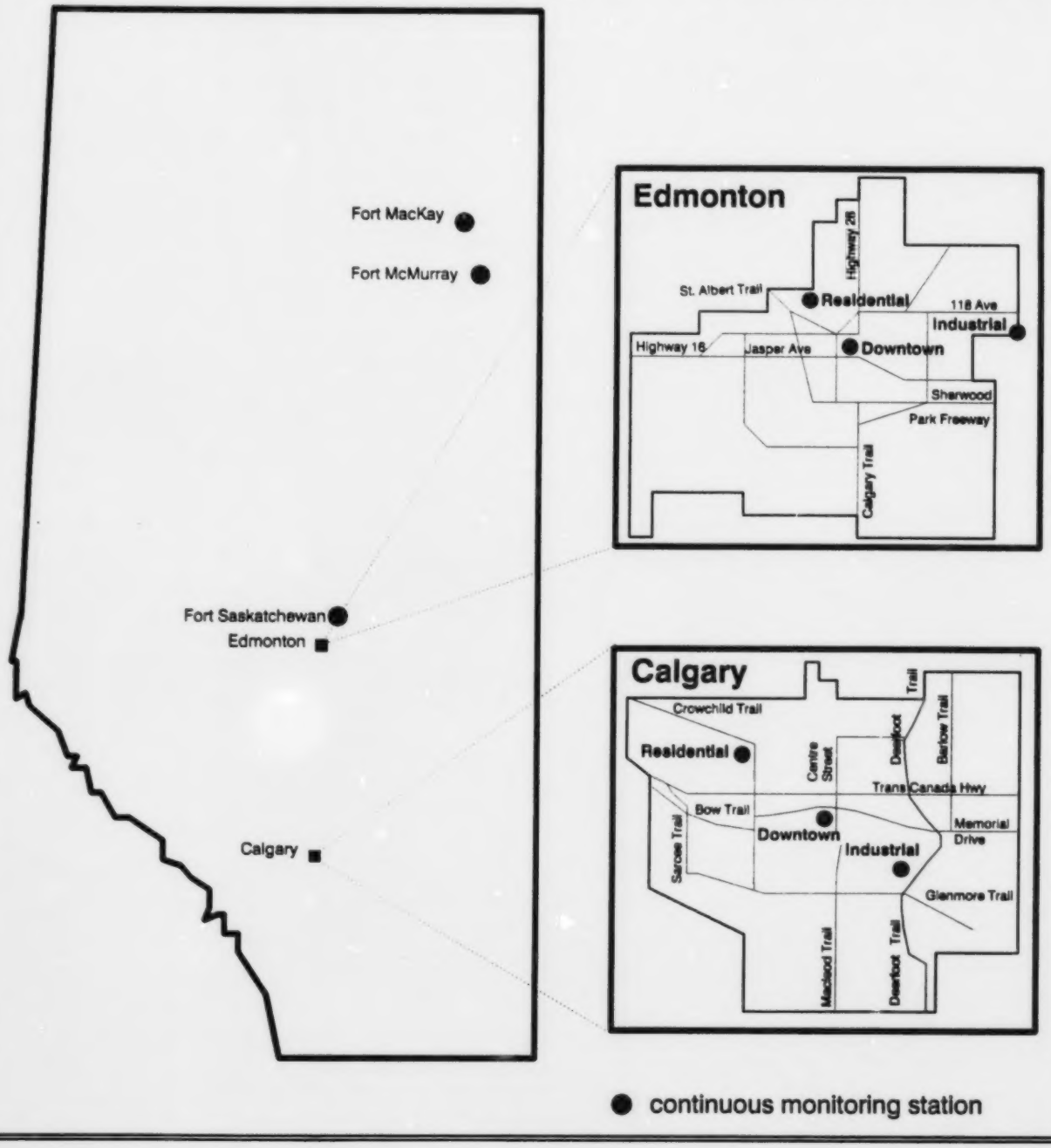
Air pollutants such as ozone, carbon monoxide, the coefficient of haze, nitrogen dioxide, sulphur dioxide, hydrogen sulphide, total hydrocarbons and ammonia are monitored continuously by Alberta Environment. Concentrations of these pollutants are reported once every hour, 24 hours a day, 365 days a year.

Ozone (O_3)

At normal outdoor concentrations, ozone is a colourless, odourless gas. However, ozone does have a characteristic sharp odour when at very high concentrations,



LOCATION OF CONTINUOUS AIR QUALITY MONITORING STATIONS



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such as that associated with lightning storms. Ozone may be produced in the lower atmosphere through a reaction involving sunlight, nitrogen dioxide and hydrocarbons. Ozone may also be transported from the upper atmosphere through a process known as tropopause folding.

The regulations for ozone are as follows:

- *0.08 ppm as a 1-hour average concentration; and*
- *0.025 ppm as a 24-hour average concentration.*

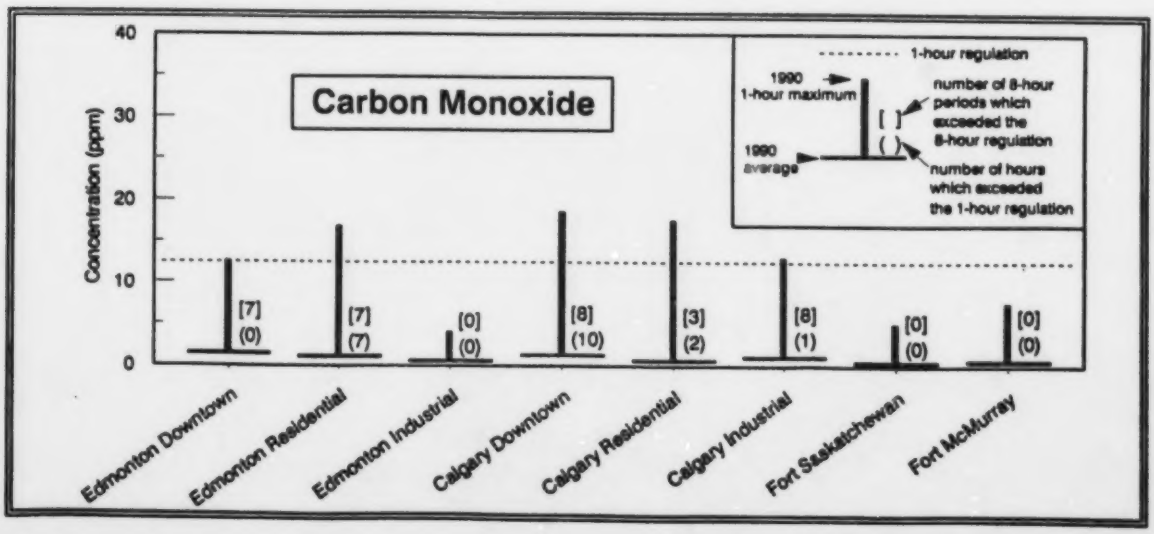
Ozone concentrations reach a maximum during the spring and summer months at all monitoring stations in Alberta. During the late spring and summer, ozone production in the lower atmosphere is a maximum due to a peak in incoming sunlight combined with stagnant weather conditions which may cause reactive pollutants to remain in the region for a prolonged period of time. Transport of ozone from rural areas may occasionally be the cause of elevated ozone levels in Edmonton and Calgary. During the early spring, high daily average ozone values may be influenced by transport of ozone from the upper atmosphere. The build-up of ozone precursors such as oxides of nitrogen and hydrocarbons during the winter may also contribute to high spring time ozone concentrations.

The 1-hour regulation for ozone was exceeded at the Fort McMurray, Fort Saskatchewan, Edmonton residential, Edmonton industrial and Calgary residential monitoring stations. The highest frequency of exceedances was at the Fort McMurray station where 18 hours exceeded the regulation.

The 24-hour regulation for ozone was exceeded on numerous occasions at all Alberta Environment stations. Fort Saskatchewan and Fort McMurray had the highest frequency of exceedances where 162 and 150 days had ozone concentrations higher than the 24-hour regulation, respectively. The least number of exceedances were indicated at the Edmonton and Calgary downtown monitoring stations.

Carbon Monoxide (CO)

Carbon monoxide is a colourless, odourless gas emitted into the atmosphere primarily by motor vehicles. Minor



sources include fireplaces, industry, aircraft and natural gas combustion.

In regulating carbon monoxide, Alberta has adopted Environment Canada's most rigorous ambient air quality regulations. Maximum permissible carbon monoxide concentrations are:

- *13.0 ppm as a 1-hour average concentration; and*
- *5.0 ppm as an 8-hour average concentration.*

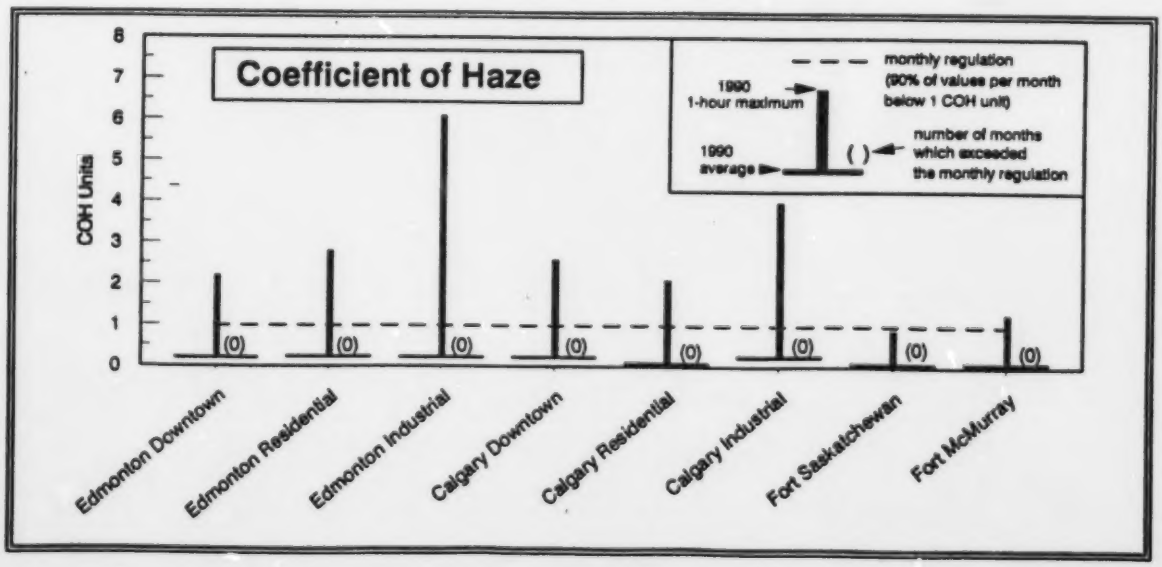
Ambient carbon monoxide concentrations exceeded the 1-hour regulation at the Edmonton residential monitoring station and all Calgary monitoring stations. The 8-hour regulation for carbon monoxide was exceeded at the Edmonton residential and downtown monitoring stations as well as at all the Calgary monitoring stations. All of these exceedances occurred in the winter with the exception of the Edmonton monitoring stations where exceedances of the regulation were also observed in the late fall and early spring. The major factor which causes exceedances of the regulation for carbon monoxide is the combination of vehicle exhaust emissions with stagnant weather conditions, such as inversions, which do not allow pollutants to disperse rapidly. Concentrations of carbon monoxide were generally at a maximum during the morning and afternoon rush hours. This pattern is especially visible at the downtown monitoring locations in Edmonton and Calgary.

Coefficient of Haze (COH)

The coefficient of haze is a measurement of the degree of dust and smoke in the atmosphere. Dust and smoke may originate from road dust, wind-blown soil, industrial sources, automobile emissions, agricultural activities and various other sources. The guideline for the coefficient of haze, which is based on visibility, established by Alberta Environment is that:

- *90% of the readings per month shall be less than 1.0 COH unit.*

The guideline for the coefficient of haze was not exceeded at any monitoring stations in 1990. The highest frequency of values greater then 1.0 COH unit was 7.6% which occurred in January at the Calgary industrial monitoring site. The



highest values were generally observed in the fall, winter and early spring seasons at all monitorng stations. Coefficient of haze values were much higher at urban stations in Edmonton and Calgary than at the more rural Fort Saskatchewan and Fort McMurray monitoring stations. Higher values were also apparent during the morning and afternoon rush hours. This is indicative of vehicular contributions to the coefficient of haze.

Nitrogen Dioxide (NO_2)

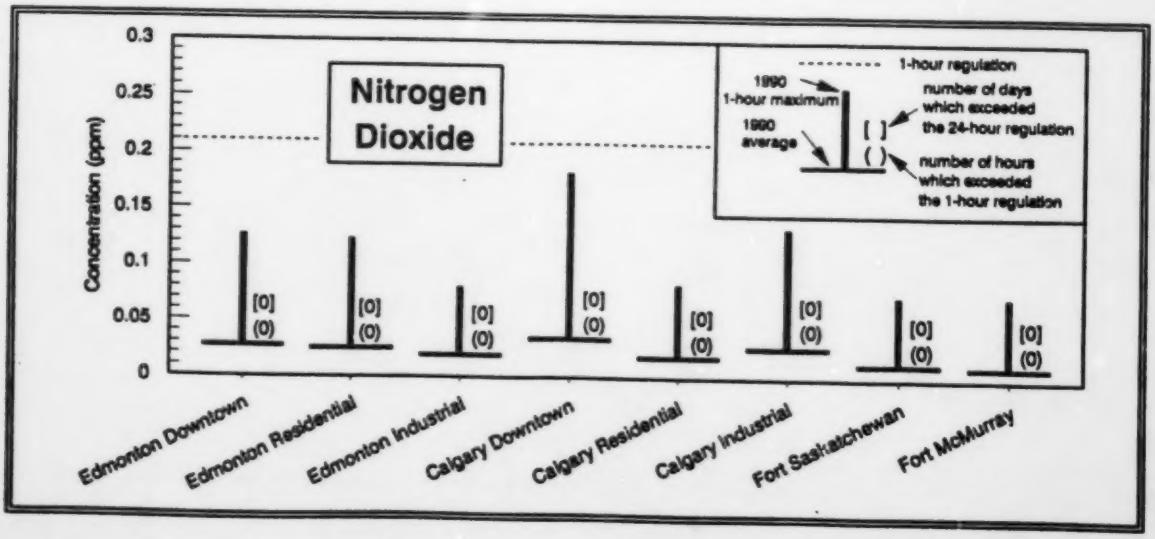
Nitrogen dioxide is a reddish-brown gas with a pungent odour which is partially responsible for the brownish discolouration of the lower atmosphere in urban locations. In Alberta, about 38% of nitrogen dioxide emissions are produced by the oil and gas industry while 29% are due to transportation (aircraft and vehicles) and 16% due to power plants. Smaller sources of nitrogen dioxide include natural gas combustion, heating fuel combustion, and forest fires. The largest urban source of nitrogen dioxide is emissions from motor vehicles.

Regulations for nitrogen dioxide are based on human health effects. The regulations are:

- *0.21 ppm as a 1-hour average concentration;*
- *0.11 ppm as a 24-hour average concentration; and*
- *0.03 ppm as an annual average concentration.*

The regulation for annual average nitrogen dioxide concentrations was exceeded only at the Calgary downtown monitoring station in 1990. The other regulations were not exceeded at any monitoring stations. The highest nitrogen dioxide concentrations were generally observed at the Edmonton downtown and residential stations as well as the Calgary downtown and industrial stations. Sources of nitrogen dioxide in these areas are vehicle exhaust and heating fuel consumption.

Maximum nitrogen dioxide concentrations are observed in the winter. This is likely due to vehicular exhaust emissions combined with persistent stable weather conditions. As with carbon monoxide and the coefficient of haze, nitrogen dioxide peaks are evident during the morning and afternoon rush hours. This is indicative of the contribution of vehicular emissions to ambient nitrogen dioxide concentrations.



Sulphur Dioxide (SO_2)

Sulphur dioxide is a colourless gas with a pungent odour. In Alberta, it is estimated that 38% of sulphur dioxide emissions are emitted by sulphur extraction plants while oil sands and power plants produce about 29% and 16% of sulphur dioxide emissions, respectively. Other sources include gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.

Alberta Environment has adopted Environment Canada's most rigorous regulations for sulphur dioxide. The following regulations are based on prevention of effects to vegetation:

- *0.17 ppm as a 1-hour average concentration;*
- *0.06 ppm as a 24-hour average concentration; and*
- *0.01 ppm as an annual average concentration.*

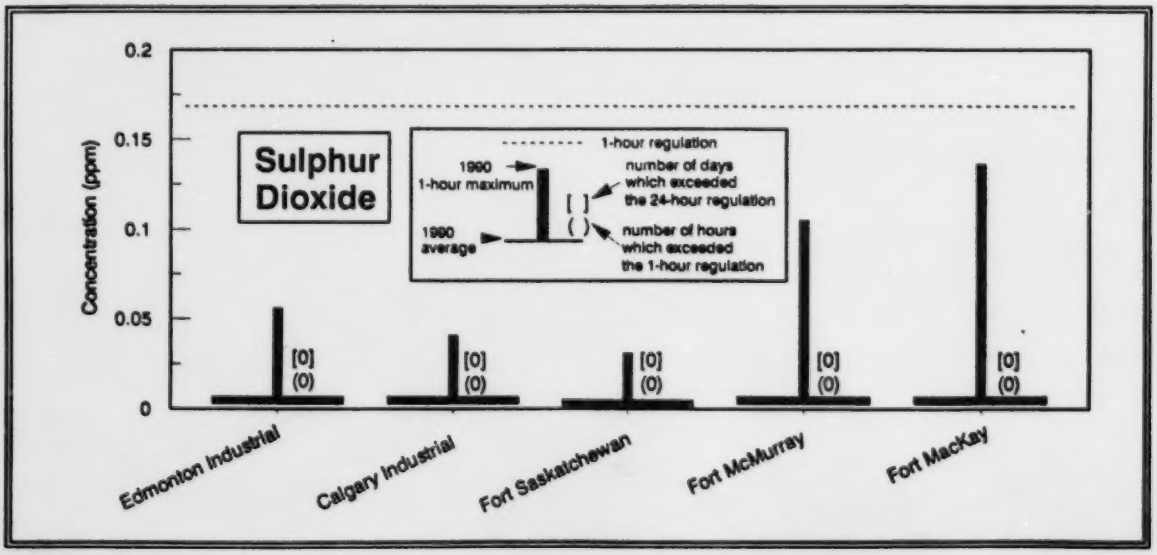
Exceedances of the regulations for sulphur dioxide did not occur at any Alberta Environment monitoring stations in 1990. Maximum 1-hour average concentrations of 0.136 and 0.105 ppm were recorded at Fort MacKay and Fort McMurray monitoring locations, respectively. Elevated sulphur dioxide readings at these locations were likely due to the oil sands processing industry.

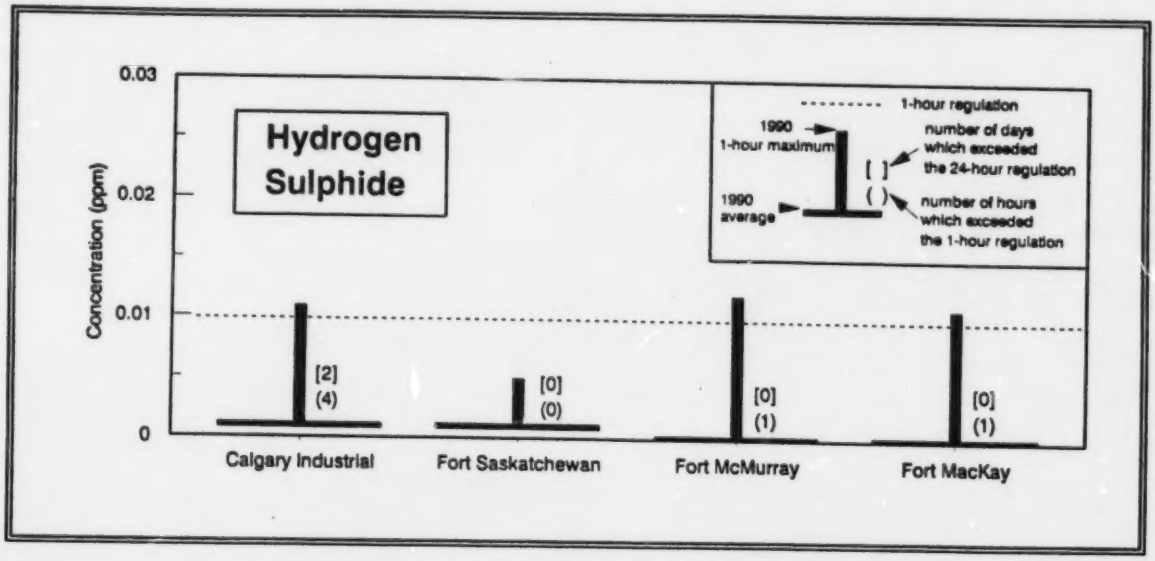
Hydrogen Sulphide (H_2S)

Hydrogen sulphide is a colourless gas with a rotten egg odour. Industrial sources include petroleum refineries, natural gas plants, petrochemical plants, coke oven plants, and pulp and paper plants which use the kraft pulping process. Natural sources of hydrogen sulphide include sulphur hot springs, sloughs, swamps and lakes.

Regulations for hydrogen sulphide are based on the odour threshold; however, many individuals can smell hydrogen sulphide at levels lower than the ambient regulation. The regulations for hydrogen sulphide adopted by Alberta Environment are:

- *0.010 ppm as a 1-hour average concentration; and*
- *0.003 ppm as a 24-hour average concentration.*





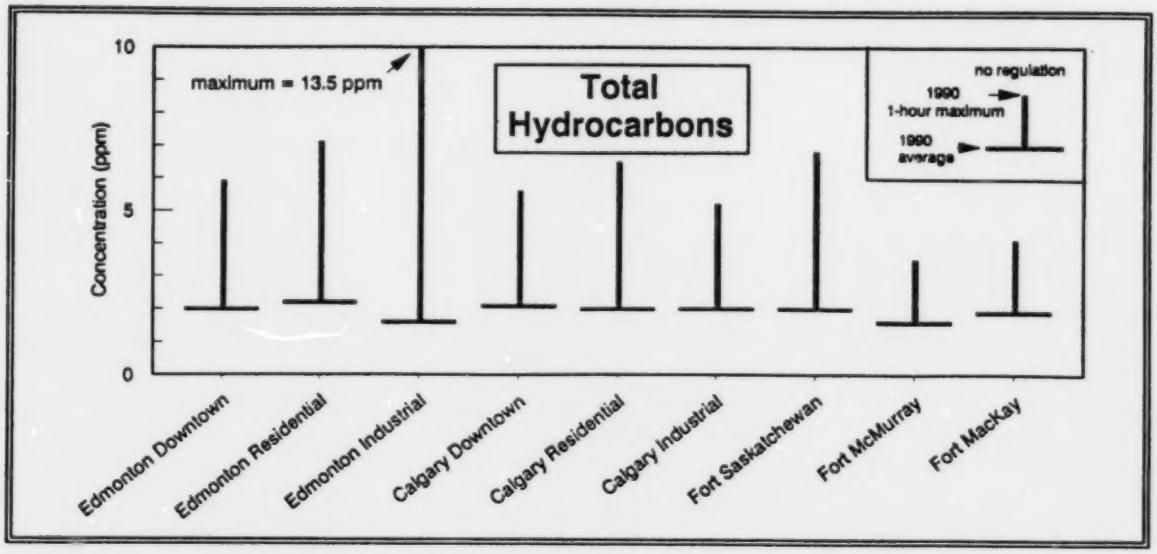
Hydrogen sulphide concentrations exceeded the 1-hour regulation at the Calgary industrial, Fort McMurray and Fort MacKay monitoring units. A maximum 1-hour average hydrogen sulphide concentration of 0.012 ppm was recorded in November at Fort McMurray. The maximum frequency of exceedances was at the Calgary industrial location where the regulation was exceeded four times. The 24-hour regulation for hydrogen sulphide was also exceeded on two occasions at this location. Sources of hydrogen sulphide in the Calgary industrial region are likely fugitive emissions from near-by industrial activities. The oil sands processing plants between Fort McMurray and Fort MacKay are the major sources of elevated hydrogen sulphide readings at these locations.

Total Hydrocarbons (THC)

The term "total hydrocarbons" refers to methane and reactive hydrocarbons. Reactive hydrocarbons (or volatile organic compounds) may react with sunlight to form ozone. Sources of hydrocarbons include vegetation, vehicular emissions, gasoline marketing and storage tanks, petroleum and chemical industries, drycleaning, fireplaces, natural gas combustion and aircraft traffic.

Hydrocarbon concentrations were the highest in the winter months at all monitoring locations. In downtown Edmonton and Calgary, maximum hydrocarbon values were observed during the morning and afternoon rush hours. This shows that vehicles are the major source of hydrocarbons at urban locations.

A maximum 1-hour average total hydrocarbon concentration of 13.5 ppm was recorded at the Edmonton industrial monitoring location. Sources of hydrocarbons in the Edmonton industrial area were likely petroleum storage tanks, refineries, vehicular emissions, painting and drycleaning. No regulations exist for ambient total hydrocarbon concentrations.

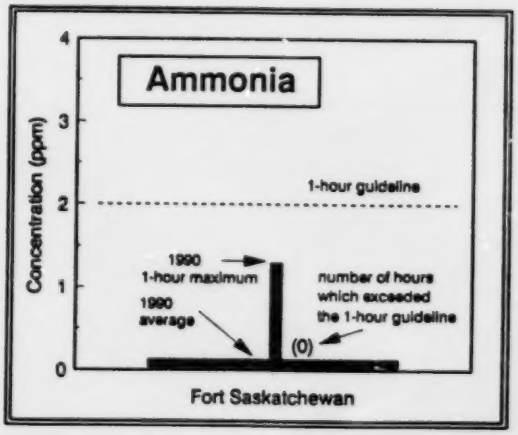


Ammonia (NH_3)

Ammonia is a colourless gas with a pungent odour. Ammonia is emitted into the atmosphere through natural sources such as animal decay and animal excretions, and man-made sources such as the fertilizer industry.

The guideline for maximum permissible ammonia concentrations is:

- *2.0 ppm as a 1-hour average concentration.*



Ammonia is monitored at Fort Saskatchewan because of its proximity to the fertilizer industry. Exceedances of the guideline for ammonia were not detected at this monitoring station. Ammonia concentrations were below the detectable limit 90% of the time. The maximum ammonia concentration measured was 1.3 ppm (parts per million).

INTERMITTENT AIR QUALITY MONITORING

Intermittent air quality monitoring refers to air pollutants which are monitored as a 24-hour accumulated loading, once every sixth day, according to the National Air Pollution Surveillance (NAPS) system. Suspended particulates, Benzo (a) Pyrene and lead are monitored according to this system. Vinyl chloride monomer is also monitored on an intermittent basis in the Fort Saskatchewan region.

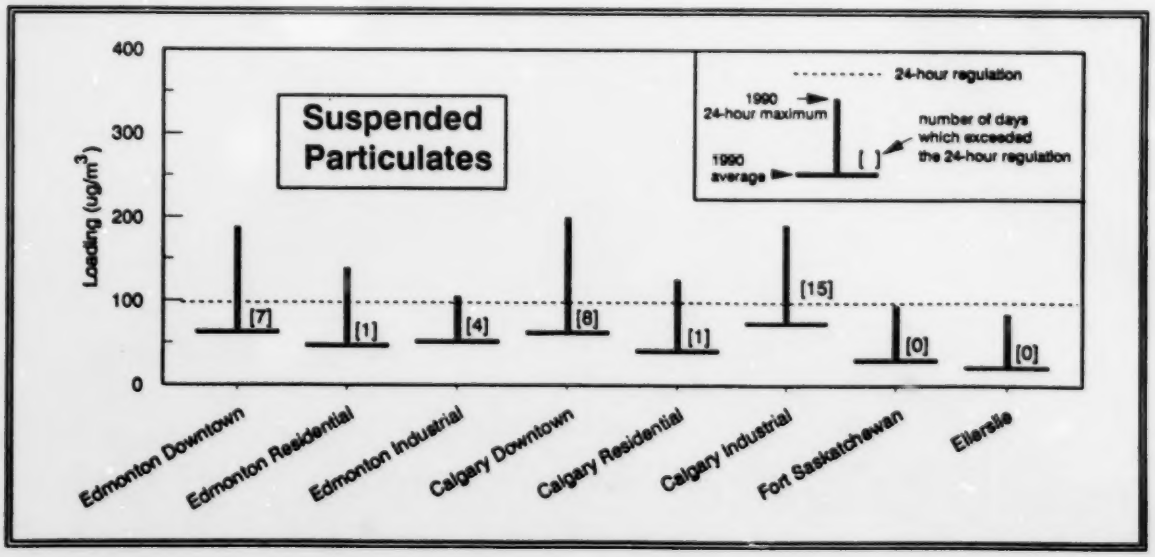
Total Suspended Particulates (TSP)

Suspended particulates are particles which range from about 0.001 to 500 microns in diameter (a human hair is about 100 microns in diameter) and, depending on their density, may remain suspended in the air for an indefinite period of time. Suspended particulates may originate from soil, road and agricultural dust; smoke from forest fires and recreational fires; vehicular exhaust emissions; and industrial sources.

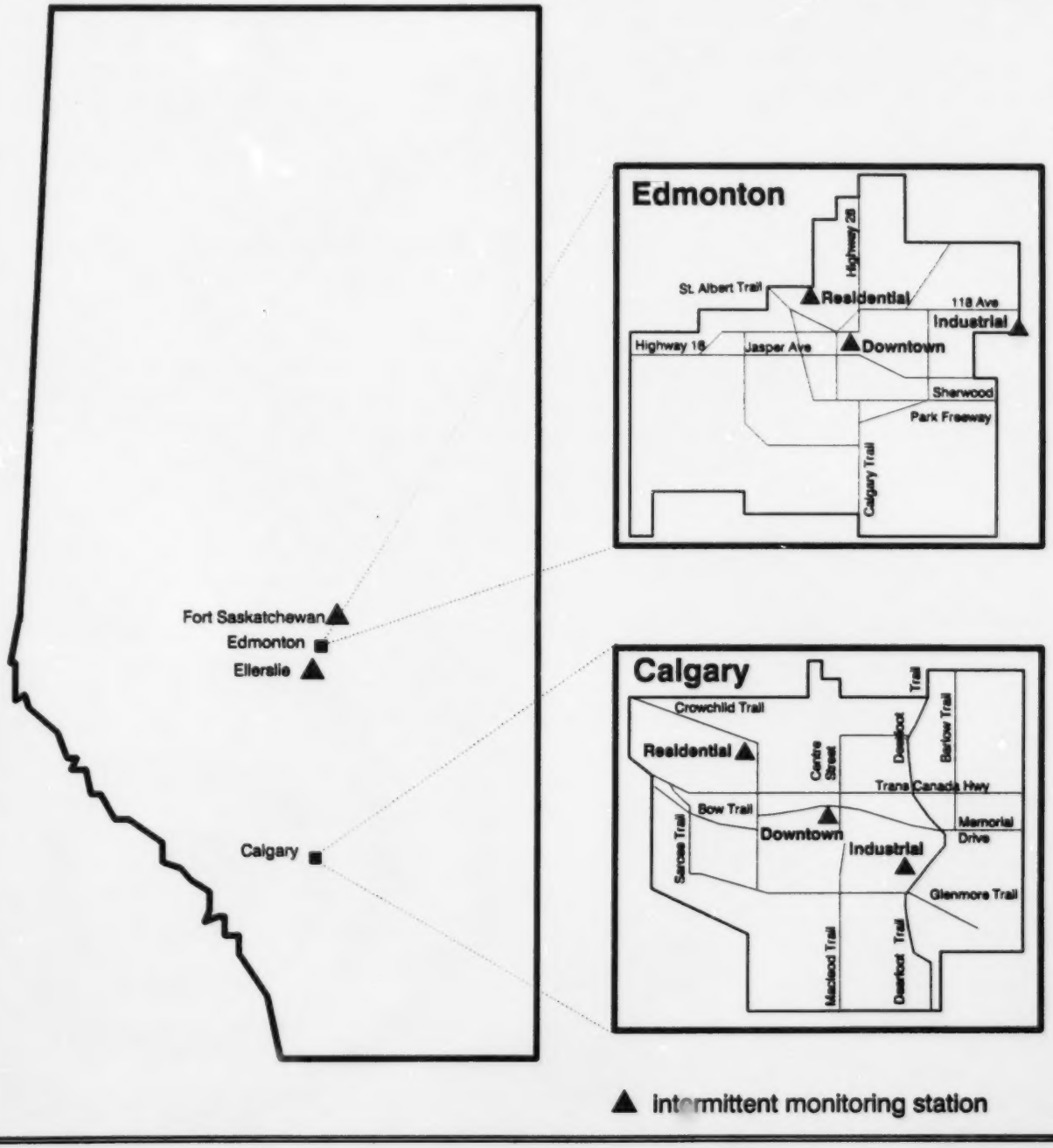
The regulations for total suspended particulates are based on nuisance effects and visibility reduction. Alberta Environment has adopted the following federal standards for total suspended particulate loadings:

- *100 ug/m^3 as a 24-hour total loading; and*
- *60 ug/m^3 as an annual average loading.*

The 24-hour regulation for suspended particulates was exceeded at all Edmonton, Calgary and Fort Saskatchewan monitoring stations. The greatest frequency of exceedances was observed at the Edmonton downtown, Calgary downtown and Calgary industrial monitoring locations. The annual average regulation was exceeded at the Edmonton downtown, Calgary downtown and Calgary industrial monitoring stations. Higher suspended particulate loadings in the downtown locations of Edmonton and Calgary are likely attributed to vehicular emissions.



LOCATION OF INTERMITTENT AIR QUALITY MONITORING STATIONS



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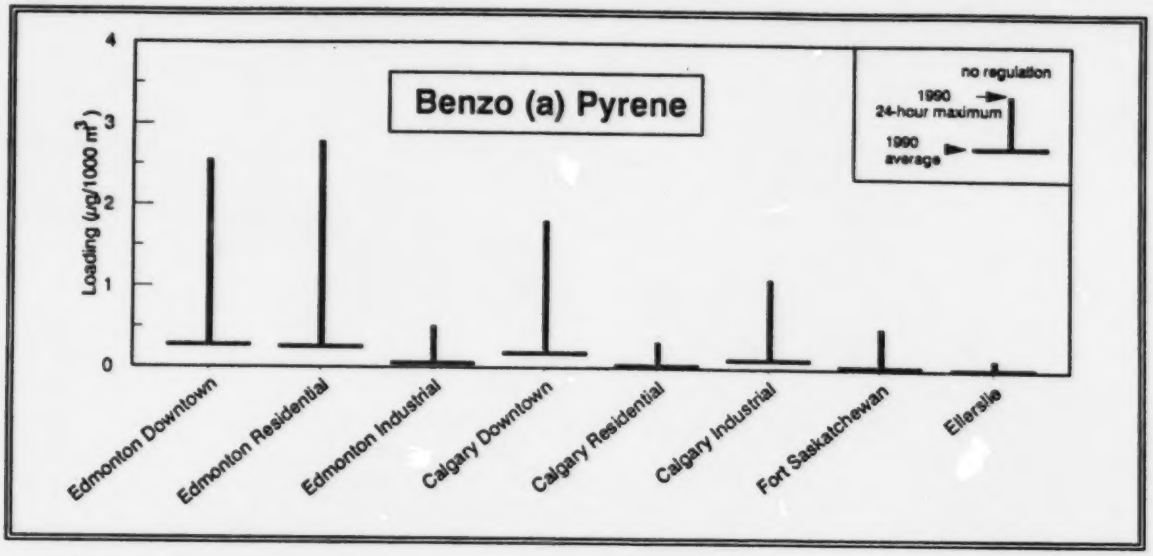


Benzo (a) Pyrene (BaP)

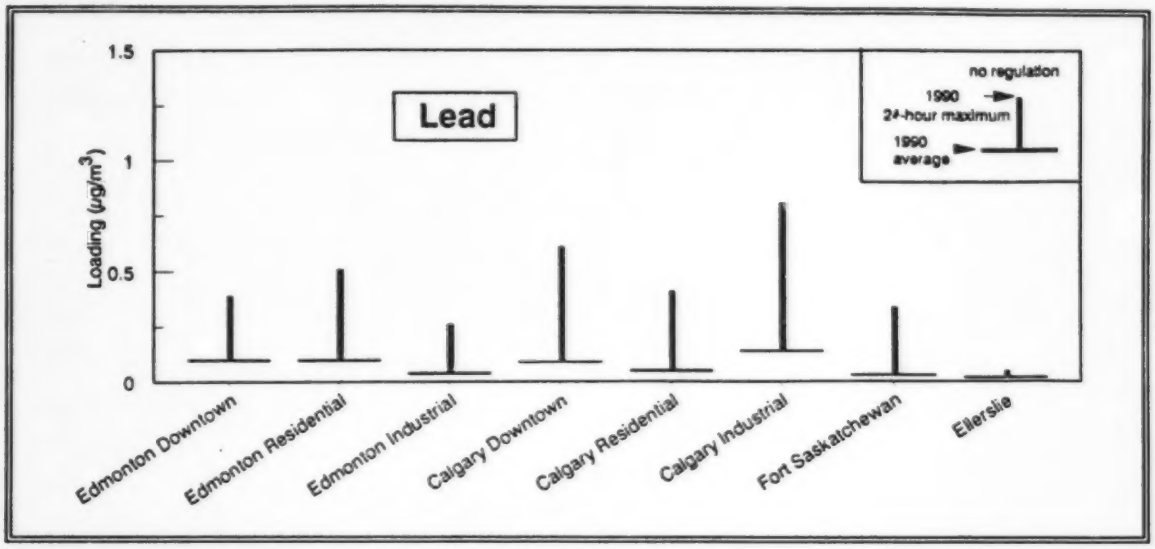
Benzo (a) Pyrene is a polycyclic aromatic hydrocarbon (PAH) that is contained in all types of soot and smoke. Vehicular exhaust, and smoke from industrial and recreational emissions are the most common sources of Benzo (a) Pyrene.

Benzo (a) Pyrene loadings at the urban locations such as Edmonton downtown, Edmonton residential, Calgary downtown and Calgary industrial were substantially greater than at the more rural monitoring locations. All stations where relatively high Benzo (a) Pyrene loadings were recorded are located close to major traffic arteries. The highest annual average loadings were observed at the Edmonton downtown and residential monitoring stations where values of 0.25 and 0.27 ug/1000 m^3 (micrograms per 1000 cubic meters of air) were recorded, respectively. The major source of Benzo (a) Pyrene at these stations is vehicular emissions. There are no ambient air regulations for Benzo (a) Pyrene in Alberta.

Lead (Pb)

Lead is emitted into the atmosphere primarily as a result of burning leaded gasoline in motor vehicles. Other sources of atmospheric lead include iron and steel manufacturing, solid waste incineration and battery manufacturing.

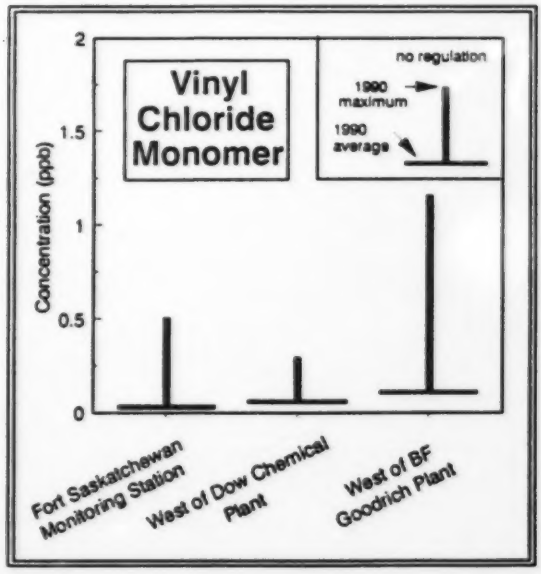
Lead loadings are much higher at locations in close proximity to major traffic arteries than in rural locations. The highest annual average lead loadings were recorded at Edmonton downtown and residential, and Calgary downtown and industrial monitoring locations. A maximum annual average lead loading of 0.14 ug/m^3 (micrograms per cubic meter of air) was recorded at the Calgary industrial monitoring station. This value is about half of the maximum annual average recorded in Alberta in 1989. Alberta Environment does not have regulations or guidelines for ambient loadings of lead.



Vinyl Chloride Monomer (VCM)

Vinyl chloride monomer is a colourless gas with a faint sweet odour under normal atmospheric concentrations. Vinyl chloride monomer is emitted into the atmosphere during the manufacturing of clothing, building and construction materials, home furnishings, and packaging for toys and plastics.

Annual average vinyl chloride monomer concentrations ranged from 0.03 ppb (parts per billion) at the Fort Saskatchewan monitoring unit, to 0.06 ppb west of the Dow Chemical plant, to 0.11 ppb at the monitoring location in the vicinity of the BF Goodrich processing plant. Alberta Environment does not have regulations for atmospheric concentrations of vinyl chloride monomer.



STATIC AIR QUALITY MONITORING

Alberta Environment conducts air quality monitoring, on a static basis, at approximately 70 networks throughout Alberta. Each network consists of at least one monitoring station. Static monitoring is the measurement of total accumulated loadings of pollutants on a one- and three-month schedule. This type air quality monitoring is useful as a simple, inexpensive indicator of trends. Parameters monitored on a static basis include total sulphation, hydrogen sulphide, dustfall, calcium and fluorides.

Total Sulphation

Total sulphation is the measurement of sulphur-containing compounds which exist in the atmosphere. Sulphur recovery gas plants, coal-burning power plants and petroleum refining plants are common sources of these gases.

The guideline for total sulphation loading in Alberta is:

- *0.50 mg SO_3 equivalent/day/100 sq cm.*

The guideline for total sulphation was not exceeded in 1990. The highest annual average total sulphation value was recorded at the Redwater network.

Hydrogen Sulphide

Hydrogen sulphide is present in the atmosphere from natural sources such as coal, natural gas, oil, sulphur hot springs, sloughs, swamps and lakes. Industrial sources of hydrogen sulphide include petroleum refining plants, natural gas plants, petrochemical complexes, coke oven plants, pulp and paper plants employing the kraft pulping process, and petroleum and gas gathering fields.

The guideline for hydrogen sulphide loading in Alberta is:

- *0.10 mg SO_3 equivalent/day/100 sq cm.*

Exceedances of the guideline for hydrogen sulphide did not occur at any static monitoring networks in 1990. The highest annual average hydrogen sulphide loading was observed at the Fort McMurray and Grande Prairie networks.

Total Dustfall

Dustfall is particulate matter which is too heavy to remain suspended in the atmosphere indefinitely. Sources of dustfall include wind-blown soil, road dust, dust generated by agricultural activities, ash from forest fires and recreational fires, and flyash from industrial sources.

The Alberta Environment guidelines for total dustfall loadings are:

- *53 mg/100 sq cm/30 days in residential and recreational areas;*
- *158 mg/100 sq cm/30 days in commercial and industrial areas;*

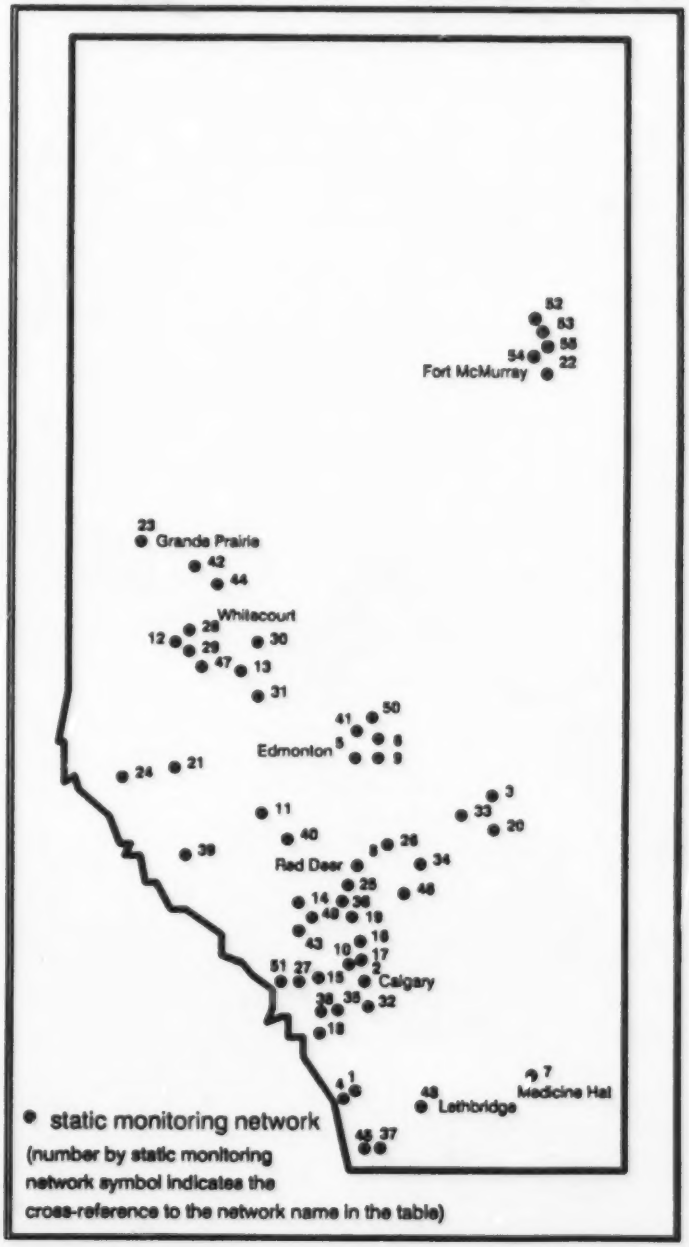
Total dustfall loadings exceeded Alberta Environment guidelines for residential regions at most networks. Guidelines for industrial regions were exceeded at six of these networks. The highest frequency of exceedances occurred at the Calgary and Lethbridge networks where 47 and 43% of samples exceeded the residential guideline, respectively.

LOCATION OF STATIC AIR QUALITY MONITORING NETWORKS

Map Location	Network Location
1	Blairmore
2	Calgary
3	Camrose
4	Coleman
5	Edmonton
6	Fort Saskatchewan
7	Medicine Hat
8	Red Deer
9	Sherwood Park
10	Balzac
11	Buck Lake
12	Bigstone
13	Blue Ridge
14	Caroline
16	Carstairs
15	Cochrane
17	Crossfield
18	Diamond Valley
19	Didsbury
20	Edburg
21	Edson
22	Fort McMurray
23	Grande Prairie
24	Hinton
25	Innisfail
26	Joffre
27	Jumping Pound
28	Kaybob
29	Kaybob (south)
30	Lone Pine Creek
31	Mayerthorpe
32	Mazeppa
33	New Norway
34	Nevis
35	Okotoks
36	Olds
37	Pincher Creek
38	Quirk Creek
39	Ram River
40	Rimbey
41	St. Albert
42	Simonette
43	Sundre
44	Valleyview
45	Waterton

Map Location	Network Location
46	Wimborne
47	Windfall
48	Lethbridge
49	Raven Brood
50	Redwater

Map Location	Network Location
51	Exshaw
52	Bitumont Tower
53	Ells Tower
54	Thickwood Tower
55	Muskeg Tower



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Calcium

Calcium emanates from natural sources such as wind-blown soil and road dust. Man-made sources of calcium in dustfall include cement, iron, steel and wood processing. There are no regulations or guidelines for atmospheric loadings of calcium in Alberta.

The highest annual average calcium loading recorded in 1990 was measured at the Exshaw network. Calcium loadings in the Exshaw area were over two times greater than those recorded in the Edmonton area. Relatively high values at the Exshaw network may be attributed to cement manufacturing activities in the vicinity.

Fluorides

Fluorides are emitted into the atmosphere through processes such as coal combustion and the processing of phosphate bearing rock.

The Alberta Environment guideline for flouride loading is:

- *40.0 ug water soluble fluorides/ 100 sq cm/ 30 days*

Fluoride loadings were the highest at the Redwater monitoring network in 1990. The guideline for flourides was not exceeded at any Alberta Environment monitoring networks.

ACID PRECIPITATION MONITORING

Rain and snow samples were collected, as an accumulation over a one-month period, at 12 locations in the province by Alberta Environment in 1990. Chemical analysis was conducted these samples to obtain pH as well as other compounds contained in precipitation. Regulations for acid precipitation are currently being developed by Alberta Environment.

pH

The most acidic (lowest pH) precipitation recorded in 1990 fell at Fort MacKay (pH of 4.8) and Fort McMurray (pH of 5.0). Relatively low annual average pH values were also measured at Beaverlodge, Fort Chipewyan and Kananaskis (pH of 5.2 or less). The least acidic precipitation was measured at High Prairie, Suffield and Calgary. The Cold Lake and Red Deer precipitation stations recorded annual average pH values close to that of uncontaminated precipitation (pH of 5.6).

Anions (sulphate, nitrate, chloride, phosphate)

Anions in precipitation may result from emissions into the atmosphere from coal-fired power plants, oil refineries, gas plants, oil sands plants, pulp and paper plants, fertilizer plants, vehicular emissions and agricultural activities.

Maximum wet sulphate deposition rates were recorded at Red Deer and Edmonton. Maximum nitrate wet deposition rates were observed at Red Deer and Kananaskis. The highest wet chloride deposition rates were observed at Fort McMurray. Wet phosphate deposition was relatively low at all monitoring stations.

Cations (calcium, ammonium, sodium, magnesium, potassium)

Cations may originate from industrial sources such as iron, steel and wood manufacturing, or natural sources such as wind-blown soil and dust.

Wet calcium deposition was a maximum at the High Prairie precipitation monitoring station. The maximum wet ammonium deposition occurred at Red Deer and Suffield. Wet potassium and magnesium deposition rates were the highest at High Prairie while wet sodium deposition reached at maximum at Fort McMurray.

LOCATION OF ACID PRECIPITATION MONITORING STATIONS

● acid precipitation monitoring station

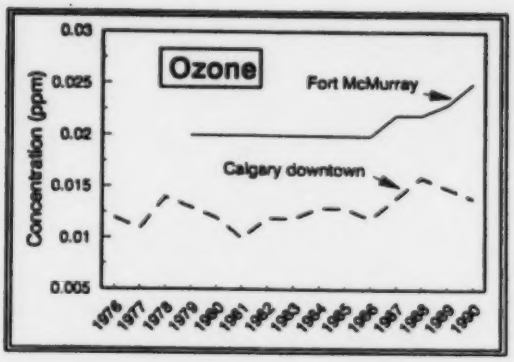
AIR QUALITY TRENDS

The long-term trend of air pollution levels is an important indicator of changes in air quality. Approximately 15 years of data are available for ozone, carbon monoxide, the coefficient of haze, nitrogen dioxide and total hydrocarbons. About 11 years of data are available for pollutants which are monitored on an intermittent basis (suspended particulates, Benzo (a) Pyrene and lead). Annual average concentrations for ammonia, hydrogen sulphide and sulphur dioxide are not high enough to resolve siginificant trends.

Ozone

Ozone is formed in the lower atmosphere primarily though the reaction of sunlight with nitrogen dioxide and hydrocarbons. The transport of ozone from the upper atmosphere to ground level may also be an important contributor to ozone levels in the lower atmosphere. At urban locations in Alberta, ozone is often destroyed by nitrogen oxide emitted by automobiles.

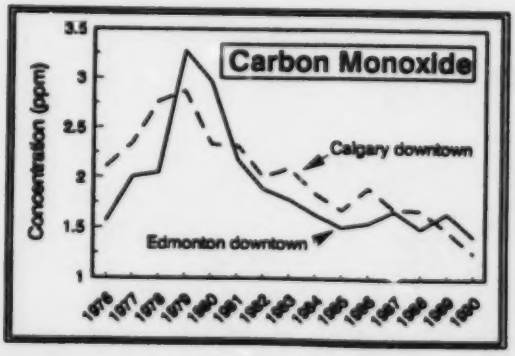
An upward trend in annual average ozone concentrations is evident from data collected at the Calgary downtown and Fort McMurray monitoring stations. These trends may be caused by a number of contributing factors including: (1) increased concentrations of nitrogen dioxide and hydrocarbons; (2) increased transport of ozone from the upper atmosphere to ground level; or (3) decreased levels of nitrogen oxide in the lower atmosphere. Significant trends are not apparent at any other monitoring stations.



Carbon Monoxide

The major source of carbon monoxide in urban areas is from vehicular emissions. Other sources include the industrial emissions, aircraft emissions, fireplaces and natural gas combustion.

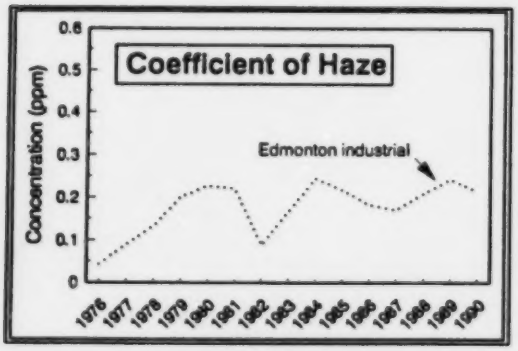
A trend toward lower carbon monoxide concentrations is evident at the Edmonton and Calgary downtown stations. A peak in annual average carbon monoxide concentrations was evident in 1979 at most monitoring stations. This peak likely reflects an increase of motor vehicle usage until 1979 and a trend towards more efficient automobiles after 1979. A downward trend is also visible at the Edmonton residential, Calgary residential and Calgary industrial monitoring stations.



Coefficient of Haze

The coefficient of haze is a measurement of dust and smoke resulting from sources such as road dust, wind-blown soil, industrial emissions, automobiles and agricultural activities.

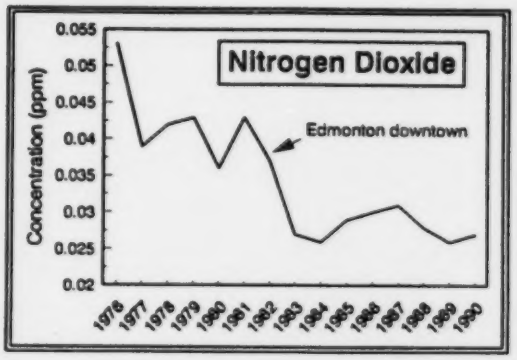
A slight increase in annual average coefficient of haze values is apparent at the Edmonton industrial monitoring station. This trend may be due to the combination of a greater traffic density in east Edmonton and increased industrial emissions in the region. Significant trends are not visible at any other monitoring stations.



Nitrogen Dioxide

Major sources of nitrogen dioxide include motor vehicle emissions, aircraft emissions, the oil and gas industry, power plants, natural gas combustion and heating fuel combustion.

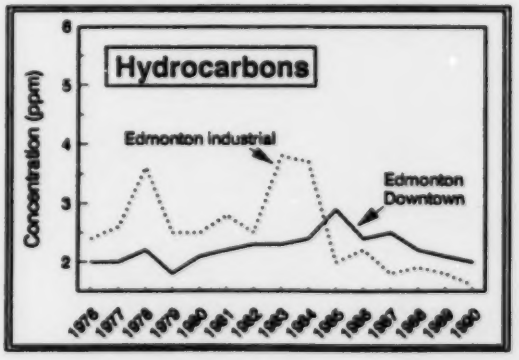
A downward trend in nitrogen dioxide is evident at the Edmonton downtown monitoring site. This trend was most pronounced from 1981 to 1983. Lower nitrogen dioxide levels may be due to decreased vehicular emissions in the downtown region of Edmonton. Trends in nitrogen dioxide levels at other stations are not apparent.



Total Hydrocarbons

Hydrocarbons may be emitted from a variety of sources. Some of these sources are vegetation, vehicular emissions, and the petroleum and chemical industries.

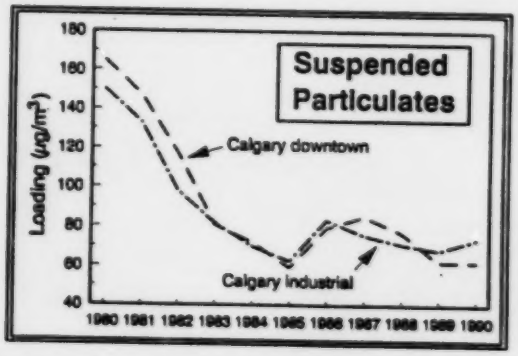
A slight decrease in annual average hydrocarbon concentrations is detectable at the Edmonton industrial monitoring station. This trend may be attributed to lower hydrocarbon emissions from industrial sources and vehicular traffic in the region. Significant trends are not apparent at other monitoring stations.



Suspended Particulates

Common sources of particulates in the atmosphere are road dust, wind-blown soil, automobile emissions, industrial emissions, and smoke from recreational and forest fires.

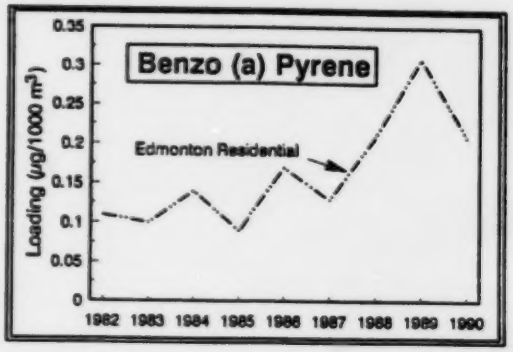
Based on 11 years of data, suspended particulate loadings show a downward trend at the Edmonton residential monitoring station and all Calgary monitoring stations. This trend is most obvious at the Calgary downtown and industrial monitoring stations. The downward trend in suspended particulate loadings is likely due to: (1) less road dust because of more paved roads; and (2) more efficient automobile engines.



Benzo (a) Pyrene

Benzo (a) Pyrene is contained in all types of smoke. Major sources of Benzo (a) Pyrene include vehicular exhaust, smoke from industrial sources, and smoke from recreational and forest fires.

A significant increase in the annual average Benzo (a) Pyrene loading is visible at the Edmonton residential monitoring station. This increase is related to a greater traffic density in the vicinity of the monitoring station. A significant decrease in the annual average Benzo (a) Pyrene loading is evident at the Edmonton residential station in 1990. Benzo (a) Pyrene levels at other monitoring stations do not indicate a significant trend.



Lead

The major source of lead in the atmosphere is automobile emissions. Other sources of lead include the manufacturing of iron and steel.

A decrease in annual average lead loadings is evident at all of the urban monitoring stations. This trend is most pronounced at the downtown locations in Edmonton and Calgary. The cause of lower lead loadings over the past 11 years, is the decrease in the use of leaded gasoline. The suspended sale of leaded gasoline at domestic gas stations is likely the reason for decreased lead loadings in 1990.